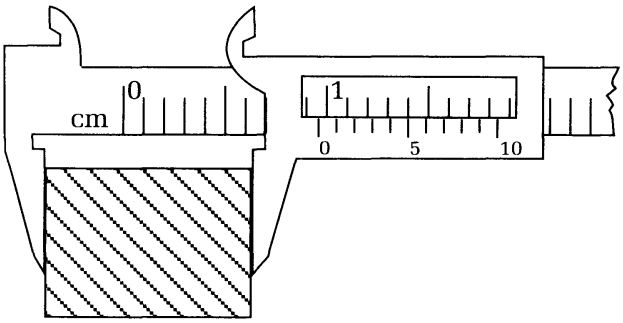
Section A (30 marks)

Answer all questions on the OTAS provided

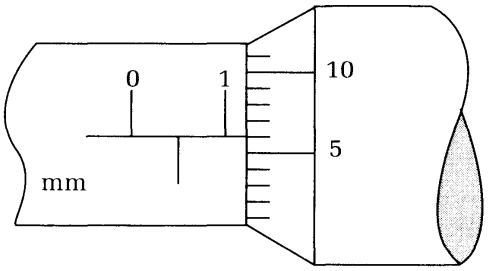
1. A pair of vernier calipers is used to measure the thickness of a piece of wood as shown in the figure below.



What is the thickness of the wood?

A 0.65 cm B 0.94 cm C 0.95 cm D 1.05 cm

2. The figure below shows the scale of a micrometer screw gauge when used to measure the diameter of a wire. What is the diameter of the wire?



A 1.06 mm B 1.14 mm C 1.16 mm D 1.60 mm

3. A simple pendulum is 1.0 m long and carries a 50 g bob. It takes 0.8 s to complete 1 swing. If the 50 g bob is replaced by a 200 g bob (with the length unchanged), how long does it take for the new pendulum to complete 1 swing?

A 0.4 s B 0.8 s C 1.6 s D 3.2 s

4. A student obtained the following values for the time for 20 complete oscillations of a pendulum.

14.5 s, 13.1 s, 14.6 s, 14.4 s

What is the period of the pendulum?

A 0.708 s B 0.725 s C 14.2 s D 14.5 s

5. Convert 2700 kg m^{-3} to g cm^{-3}.

A 2.7 g cm^{-3} B 27 g cm^{-3} C 270 g cm^{-3} D 27000 g cm^{-3}

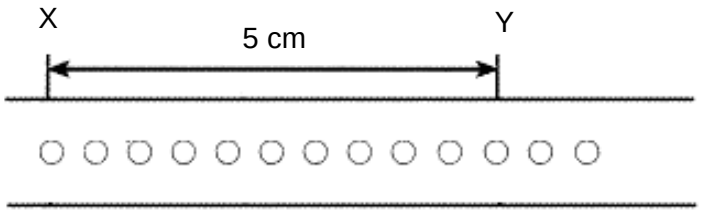
6. Which row correctly shows one scalar and one vector?

	Scalar	**Vector**
A	displacement	acceleration
B	pressure	displacement
C	work	kinetic energy
D	speed	pressure

7. The resultant of 2 forces acting on the same point simultaneously will be greatest when the angle between them is

A 0° B 45° C 90° D 180°

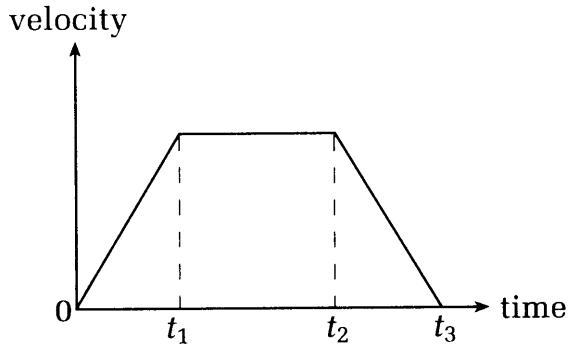
8. The diagram below shows a strip of paper tape that has been pulled under a vibrating arm by a moving object. The arm is vibrating regularly, making 50 dots per second.



At what average speed is the object moving at between X and Y?

A 0.2 cm s^{-1} B 25.0 cm s^{-1} C 50.0 cm s^{-1} D 250 cm s^{-1}

9. The velocity - time graph of a car is as shown in the figure below.



Which of the following deductions is **not** correct?

A From time t = 0 to t = t_1, the acceleration of the car is constant.
B From time t = t_1 to t = t_2, the velocity of the car is constant.
C From time t = t_2 to t = t_3, the car decelerates.
D At time t = t_3, the car is back at its initial position.

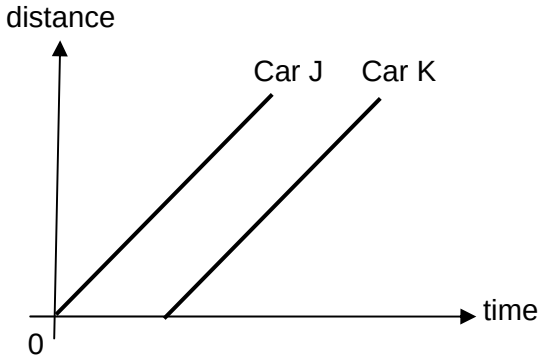
10. A sprinter completes a 100 m circular track in 10.0 s. What is his average velocity?

A 0 m s^{-1} B 10 m s^{-1} C 90 m s^{-1} D 110 m s^{-1}

11. Four students try to explain what is meant by acceleration. Which explanation is correct?

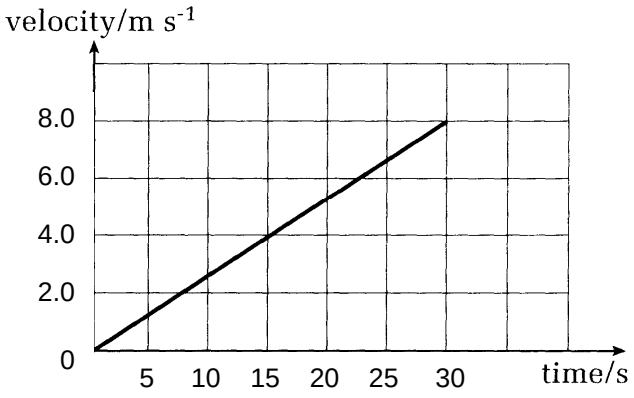
A The change in the velocity of an object in one second.
B The distance an object travels in one second.
C The force acting on an object divided by the distance it travels in one second.
D The force acting on an object when it is near to the Earth.

12. The graph below shows the motion of two cars over a period of time. From the information in the graph, which statement is correct?



A Car J accelerates at the same rate as car K.
B Car J and K always travel at constant speed.
C Car J is travelling at a higher speed than car K.
D Car J starts at a greater acceleration than car K.

13. A body of mass 42 kg moves from rest and is acted upon by a force. Its velocity varies with time as shown in the figure below.



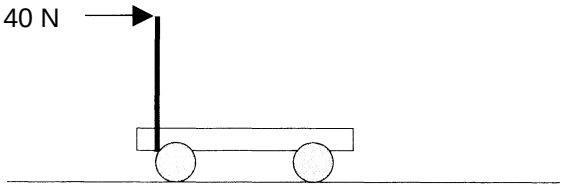
What is the force on the body?

A 11.2 N B 15.8 N C 120 N D 240 N

14. A coin and a feather are both released from the same height and allowed to fall through the air. Which of the following statements about the terminal velocities and air resistance is correct?

A The terminal velocity of the coin is greater as it experiences a greater air resistance.
B The terminal velocity of the coin is greater as it experiences a smaller air resistance.
C The terminal velocity of the feather is greater as it experiences a greater air resistance.
D The terminal velocity of the feather is greater as it experiences a smaller air resistance.

15. A man pushes a trolley with a force of 40 N and it moves with a constant velocity of 5 m s^{-1}.



What is the frictional force and the acceleration of the trolley?

	Frictional force	Acceleration
A	0 N	0 m s^{-2}
B	0 N	8 m s^{-2}
C	40 N	0 m s^{-2}
D	40 N	8 m s^{-2}

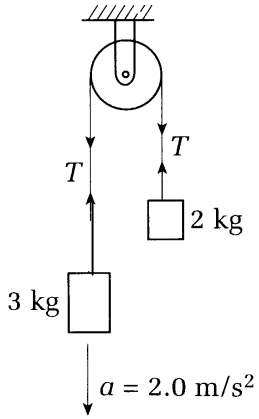
16. Which factor does not affect the frictional force between two surfaces on a horizontal plane?

A Materials in contact
B Area of contact
C The force pressing the surface together
D The nature of the surfaces in contact

17. A 3 kg mass is connected to a 2 kg mass by a light inextensible string over a smooth pulley. When the masses are released, the 3 kg mass accelerates downwards at 2.0 m s^{-2}. (g = 10 m s^{-2})

What is the tension T in the string?

A 6 N
B 10 N
C 24 N
D 30 N



18. A ball is dropped from the top of a 20-storey HDB flat. What are the forces acting on the ball immediately after it is released?

A The weight acting downwards.
B The weight and a resultant force acting downwards.
C The weight acting downwards and an upward retarding force.
D The weight and a retarding force, both acting downward.

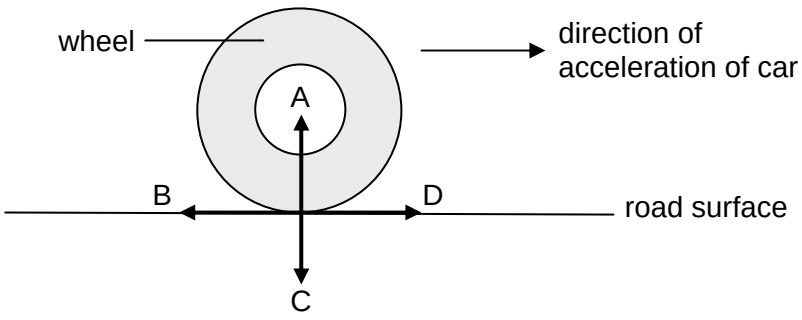
19. Two identical balls, ball A on Earth and ball B on the Moon are thrown upwards with the same force at the same time. Which of the following statements is **true**?

A Ball A will travel a greater distance as the gravitational field strength on Earth is greater than that of the Moon.
B Ball B will travel a greater distance as the gravitational field strength on Earth is greater than that of the Moon.
C They will travel the same distance as they have the same mass.
D They will travel the same distance as an equal force is applied to the balls.

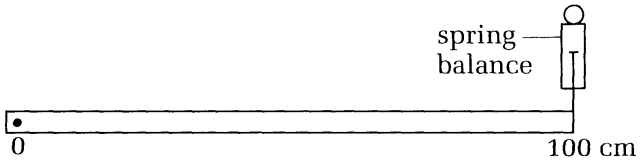
20. The mass of an empty beaker is 72.0 g. 50 cm^3 of a liquid of density 0.80 g cm^{-3} is poured into the beaker. What is the total mass of the beaker and the liquid?

A 32.0 g B 97.6 g C 112.0 g D 122.0 g

21. The wheel of a moving car is driven by the engine. The wheel is accelerating in the direction shown. In which direction does the frictional force act on the wheel?



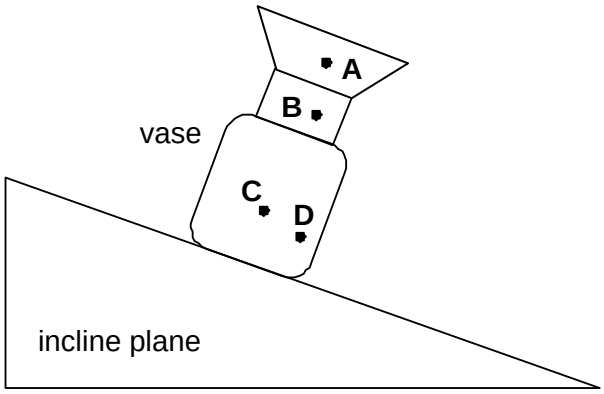
22. A uniform metre rule of weight 2.4 N is freely hinged at the 0 cm mark and supported horizontally by a spring balance at the 100 cm mark.



What is the reading of the spring balance?

A 1.2 N B 1.8 N C 2.4 N D 4.8 N

23. The diagram below shows a vase placed on an incline plane. The vase does not tilt over. Where is the most probable centre of gravity of the vase?



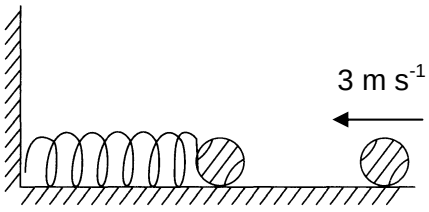
24. A motor rated at 100 W is used to lift a mass of 50 kg through a height of 6.0 m at a constant speed. What is the time taken? ($g = 10\ m\ s^{-2}$)

A 3.0 s B 12 s C 30 s D 60 s

25. A man applied a force of 80 N for 2 seconds to push a crate along a horizontal surface through a distance of 10 m. The frictional force opposing the motion is 60 N.
How much of the work done is converted into kinetic energy of the crate and how much power is exerted by the man?

	Kinetic energy / J	Power / W
A	200	100
B	200	400
C	800	100
D	800	400

26. The figure below shows the free end of a sprint being compressed by a ball bearing of mass 500 g. Before compressing the spring, the ball bearing was moving with a speed of 3 m s^{-1}.



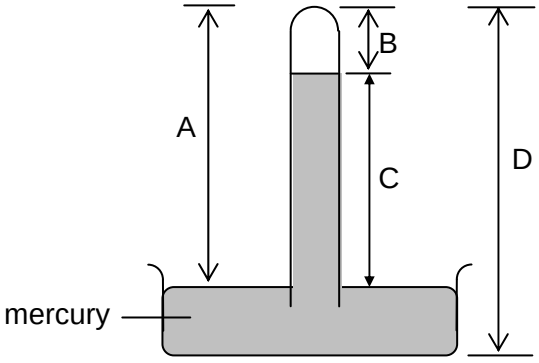
What is the maximum energy stored in the spring when the ball bearing stops?

A 0.75 J B 2.25 J C 1500 J D 2250 J

27. Which would be the **least** likely to sink into soft ground?

A A loaded lorry with four wheels.
B A empty lorry with four wheels.
C A loaded lorry with six wheels.
D A empty lorry with six wheels.

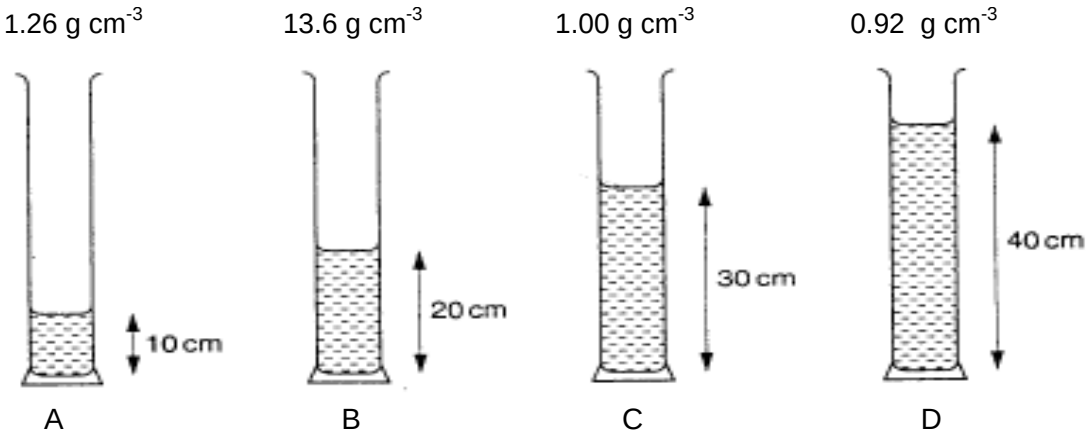
28. The diagram below shows a simple barometer.



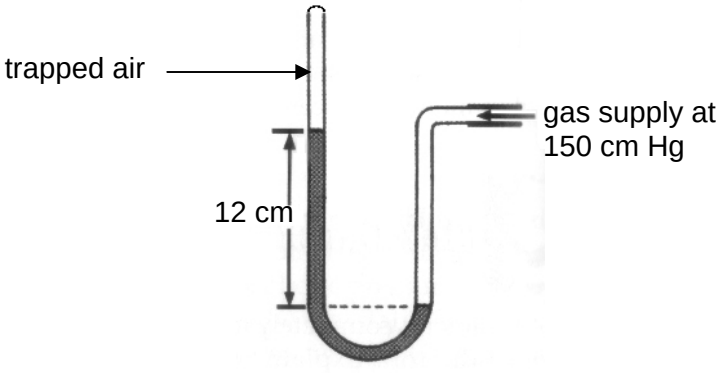
Which height is a measure of the atmospheric pressure?

29. Four different liquids are poured into identical measuring cylinders. The diagrams show the heights of the liquids and their densities.

Which liquid causes the largest pressure on the base of its measuring cylinder?



30. If the atmospheric pressure is 76 cm Hg, what is the pressure exerted by the trapped air?

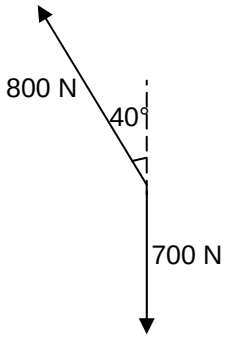


A 62 cm Hg B 88 cm Hg C 138 cm Hg D 162 cm Hg

Section B (40 marks)

Answer **all** the questions. Write your answers in the spaces provided.

1. The diagram below shows two forces acting through the centre of gravity of a large object which is being raised by a man using a lever.



(a) By using a scale drawing, find the magnitude and direction of the resultant of these forces. [4]

(b) The mass of the object is 25 kg. What is the acceleration of the object? [2]

2. The following information is adapted from the Highway Code for car drivers.
The table below shows the thinking distances and braking distances for different speeds of the car. The thinking distance is the distance the car travels between the time a hazard is spotted by the driver and the time he applies the brakes. The braking distance is the distance the car travels before coming to a stop after the brake has been applied.

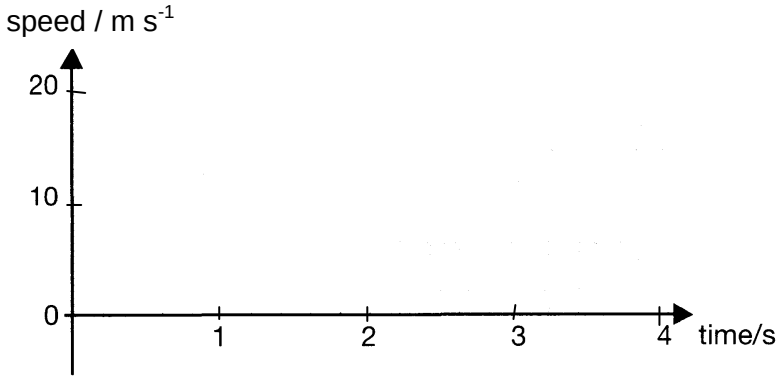
Speed of car / m s^{-1}	Thinking distance / m	Braking distance / m
10	7.0	7.5
20	14.0	30.0
30	**X**	67.5

Assume that the distances shown are the shortest for an emergency stop at the speeds stated. Also while the car driver is reacting, the car continues with constant speed within the thinking distance. While the brakes are applied, the car slows down at a steady rate.

(a) (i) What is the reaction time of the driver? [2]

(ii) Hence, deduce the value of **X**? [1]

(b) (i) Sketch on the axes given below, the speed - time graph of the car travelling at the speed of 20 m s^{-1}. [2]



(ii) Hence, determine the duration of time in which the brake has been applied before the car comes to a stop. [2]

3. (a) What is meant by:

(i) mass of an object? [1]

(ii) gravitational field strength, g? [1]

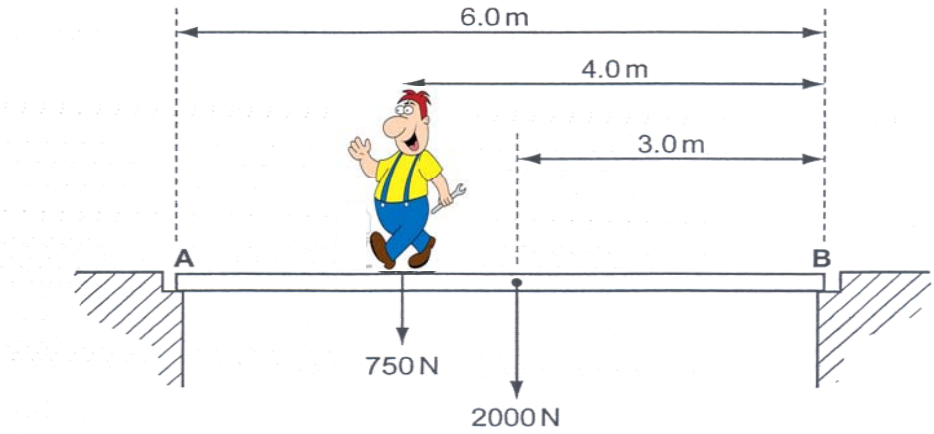
(b) A metal block is lowered into a displacement can filled with water. The density of water is 1.0 g cm^{-3} and the volume of water displaced is 64 cm^3.

(i) If the mass of the metal block is 544 g, calculate the density of the metal. [2]

(ii) The same metal block is then lowered into a displacement can filled with a liquid **P**. The mass of the liquid **P** displaced is 51.2 g. What is the density of liquid **P**? [1]

(iii) Another liquid **Q** of density 1.2 g cm^{-3}, water and liquid **P** are poured into a beaker. Draw a diagram showing clearly the positions of the layers of water, liquid **P** and liquid **Q**. Given that the 3 liquids do not mix. Label your digaram clearly. [1]

4. Diagram below shows a man crossing a bridge. The bridge is supported at points A and B. The length of the bridge is 6.0 m and its weight is 2000 N. The man weighs 750 N and he is 4.0 m from point B.



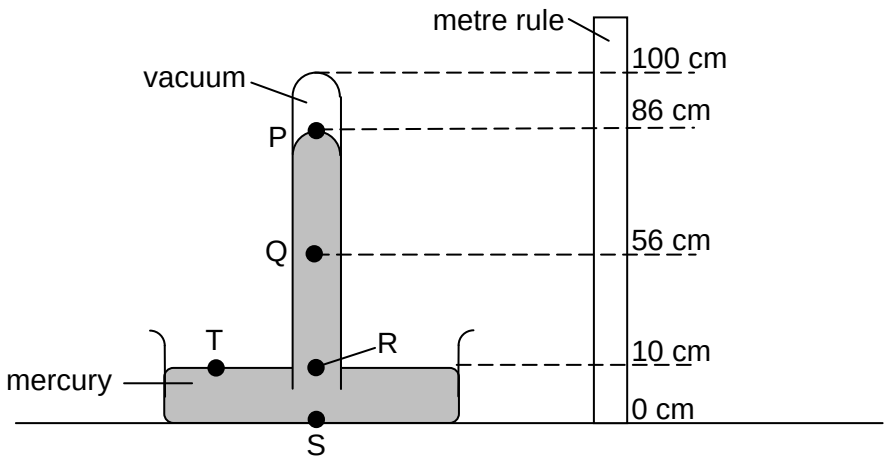
(a) Calculate the moment of the weight of the bridge about point B. [2]

(b) Calculate the moment of the weight of the man about point B. [1]

(c) Calculate the force exerted by the ground on the bridge at point A. [2]

(d) Calculate the force exerted by the ground on the bridge at point B. [2]

5. The diagram below shows a simple mercury barometer.



(a) What is the pressure, in cm Hg, inside the tube at point [4]

(i) P : _____

(ii) Q : _____

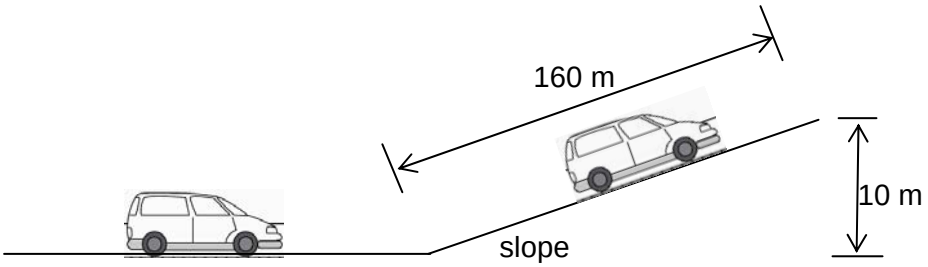
(iii) R : _____

(iv) T : _____

(b) Given that the density of mercury is 13.6 g cm^{-3} and the gravitational field strength is 10 N kg^{-1}, determine the pressure at point S, on the bottom of the mercury reservoir. [2]

(c) State what happens to the level of the mercury in the tube when atmospheric pressure increases. [1]

6. A petrol-driven car accelerated from rest to its cruising speed along a straight level road. It then climbs a slope with no change of speed.



(a) Explain whether the rate of petrol consumption will increase, stay the same or decrease. [1]

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(b) On the diagram above, where **the car is moving up the slope**, draw labelled arrows to show
(i) the direction of the force due to gravity on the car, F_g. [1]
(ii) the direction of the force due to friction on the car, F_f. [1]

(c) The car of mass 640 kg, moves up the slope at a steady speed as shown in the diagram above. The average force of friction is 200 N. Take the value of g to be 10 m s^{-2}.

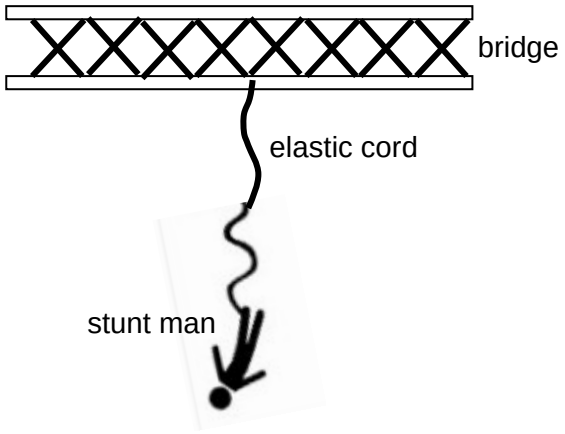
(i) Calculate the work done by the car against friction as it moves up the slope. [2]

(ii) Calculate the total work done by the car when it reaches the top of the slope. [2]

Section C (30 marks)

Answer **all** the questions. Write your answers in the spaces provided.

7. A stunt man has one end of a thick elastic cord attached to him, the other end of the cord is firmly attached to a point on a high bridge. When the man jumps from the bridge he falls freely under gravity for 2.5 s. Take the acceleration of free fall to be 10 m s^{-2} and assume that the man is initially at rest.



(a) Calculate

(i) the vertical speed the man acquires during his free fall, [2]

(ii) the vertical distance fallen through by the man during his free fall. [2]

(b) Suggest one reason why, in a real jump, the distance fallen in 2.5 s and the speed reached would be less than your calculated answers, even though the cord was slack throughout the 2.5 s. [1]

(c) After 2.5 s, the cord begins to stretch and the man falls with continual reducing downward acceleration. Why is this so? [2]

(d) (i) Eventually his downward acceleration becomes zero. Explain why this happens. [1]

(ii) If the mass of the man is 80 kg, determine the tension in the cord when his downward acceleration is zero. [2]

8. (a) Explain what is meant by

(i) centre of gravity, [1]

(ii) moment of a force. [1]

(b) Figure 8.1 show a metal sheet in the shape of an equilateral triangle. It is freely pivoted at P by a horizontal nail through a hole. The centre of gravity of the sheet is marked C.

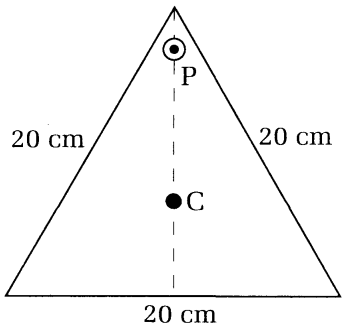


Figure. 8.1

Is the metal sheet in stable, unstable or neutral equilibrium? Explain your answer. [2]

(c) In figure 8.2, a coin of weight 0.50 N is now fixed to the sheet at Q. The loaded sheet is held steady in its original position.

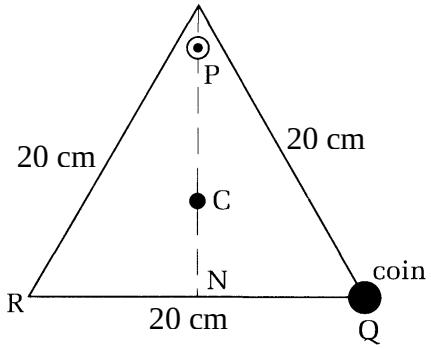


Figure. 8.2

(i) Calculate the turning effect of the weight of the coin about P. [2]

(ii) You are provided with another coin of weight 0.80 N. This coin, when fixed at a point along RQ, returns the sheet to its original position. Calculate the distance of the coin from R. [3]

(iii) On figure 8.2, mark a point **X** along the line PN which you think is roughly the new position of the centre of gravity of the sheet with the two coins fixed at the positions mentioned above. [1]

9. A falling hammer is used to drive a hollow steel post into the ground as shown in the Figure 9.1 below. The hammer is lifted by an electric motor and then falls freely to hit the baseplate.

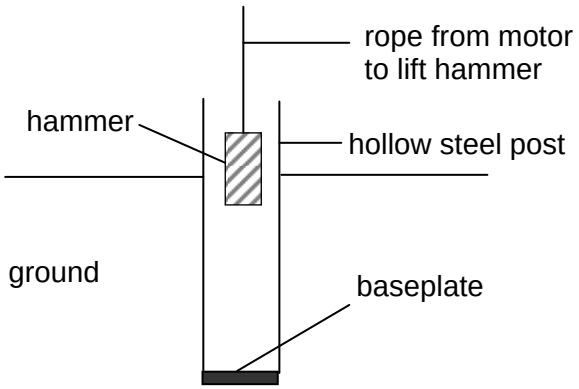


Figure. 9.1

(a) (i) State the Principle of conservation of energy. [1]

(ii) Describe the energy conversion that takes place as the hammer falls, starting from the initial potential energy of the hammer before it is dropped. [1]

(b) The metal hammer has a mass of 1600 kg and it hits the baseplate with a speed of 9.0 m s^{-1}.

(i) Calculate the kinetic energy of the hammer as it hits the baseplate. [2]

(ii) State the initial gravitational potential energy of the hammer before it falls. [1]

(iii) Calculate the height above the baseplate from which the hammer is dropped. Take g to be 10 N kg^{-1}. [2]

(c) (i) The electric motor raises the hammer through the height calculated in (b)(iii) in 3.0 minutes. Calculate the output power of the motor. [2]

(ii) State one way that would cause the baseplate to move further into the ground each time the hammer falls. [1]

END OF PAPER